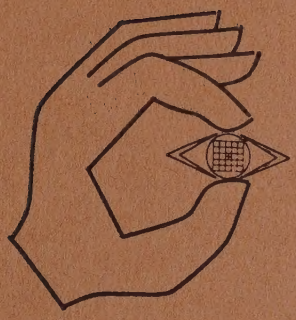

TELEQUIPMENT
OSCILLOSCOPE
VERTICAL MODULE

TYPE V4

GENERAL ELECTRIC CO.
Instrumentation & Control
228 W. Florence Ave.
Inglewood, Calif. 90301

MANUAL

TELEQUIPMENT

VERTICAL MODULE

TYPE V4

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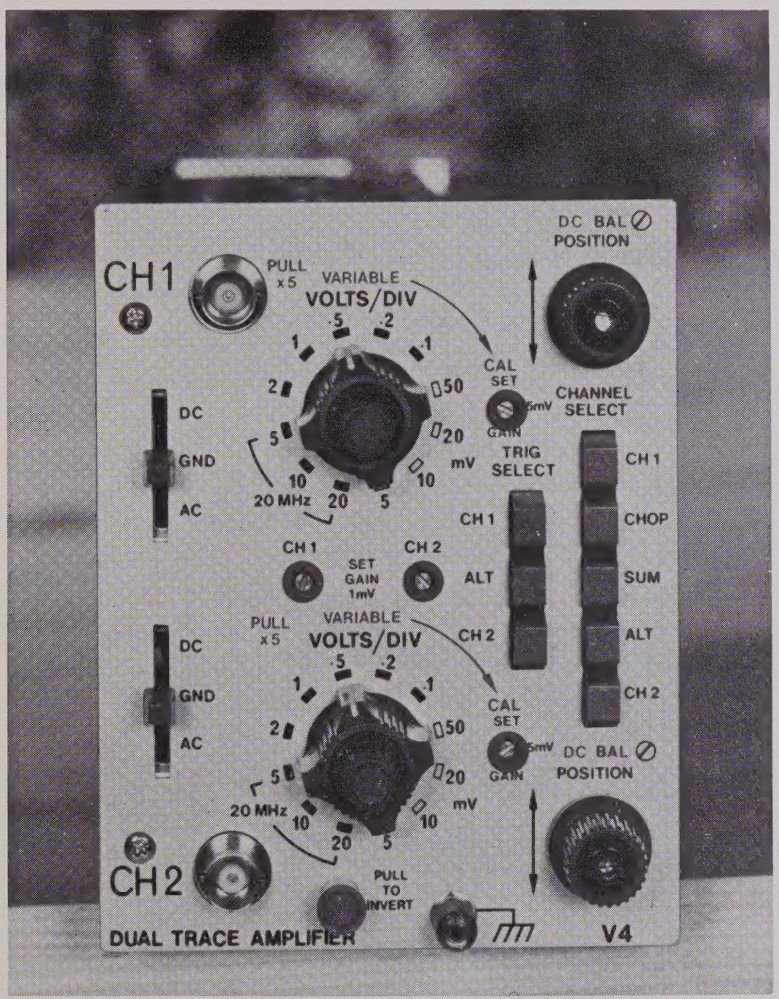
INTRODUCTION

The V4, a 50 MHz dual-trace module, provides the parent unit with dual trace vertical facility, which displays either channel separately, adds channels algebraically, alternates or chops between channels.

This manual should be read in conjunction with the module manuals. References are annotated "PU" and "S" for the parent unit and sweep module respectively.

The design of this instrument is subject to continuous development and improvement, consequently this instrument may incorporate minor changes in detail from the information contained herein. This would, in the main, affect the Components List and Circuit Diagrams. The reader should pay particular attention to the notes at the beginning of Chapter 5.



NOTICE TO OWNER

To obviate the risk of damage during transit and facilitate packaging; do NOT send the following items unless they are suspect, should this Instrument be returned to TELEQUIPMENT for servicing.

Manual
Probes
Plug Assemblies

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CHAPTER 1
SPECIFICATIONS

1.1 OPERATING MODE

Channel 1

Channel 2 (normal or inverted)

Channel 1 & 2. Summed.
Alternate
Chopped (at 350 kHz)

3 dB bandwidth	X1	X5
5 mV — 2 V/div	50 MHz	15 MHz
5 V — 20 V/div	20 MHz	12 MHz
Risetime	7 ns	23 ns
Sensitivity	5 mV to 20 V/div	1 mV to 20 V/div

Deflection factors

Calibrated (12 ranges 1.2.5 sequence)	5 mV — 20 V/div ±3%
	1 mV — 4 V/div ±3%
Input impedance	1 MΩ, 29 pF in parallel
Voltage	400 V D.C. + A.C. peak max.
Trigger Sources	Channel 1 only
	Channel 2 only
	Alternate (from display signal)

Channel — Channel

Breakthrough	>34 dB up to 50 MHz

CHAPTER 1
SPECIFICATIONS

1.1 OPERATING MODE

Channel 1
Channel 2 (normal or inverted)
Channel 1 & 2 Summed
Alternate
Chopped (at 380 kHz)

3 dB bandwidth		
5 mV — 2 V/div	... ...	50 MHz
5 V — 20 V/div	... ...	20 MHz
Risetime	... ...	7 ns
Sensitivity	... ...	5 mV to 20 V/div

18 MHz
12 MHz
29 ns
1 mV to 20 V/div

Deflection Factors

Calibrated (12 ranges 1-2-5 sequence) 5 mV — 20 V/div ±3%
1 mV — 4 V/div ±3%

Input Impedance ... ... 1 MΩ, 29 pF in parallel

Voltage ... ... 400 V D.C. + A.C. peak max

Trigger Sources ... ... Channel 1 only
Channel 2 only
Alternate (from display signal)

Channel — Channel

Breakthrough ... ... -34 dB up to 50 MHz

CHAPTER 2

OPERATING INSTRUCTIONS

2.1 FUNCTION OF CONTROLS AND CONNECTORS

These are situated on the front panel except where otherwise specified. For those controls not covered below, reference should be made to Chapter 2, in the manuals for the parent unit and "S" module.

2.1.1 **CRT** "PU" Manual.

2.1.2 **SWEEP** "S" Manual.

2.1.3 **TRIGGER** "S" Manual.

2.1.4 **VERTICAL**

DC-GND-AC — selects the input signal coupling.
In the DC position, the signal from the CH1/CH2 connector is coupled directly to the attenuator.
In the AC position a capacitor is inserted in series.
In the GND position the input to the attenuator is grounded, and the input socket is isolated; this position enables the 0 V D.C. level of a trace to be ascertained.

VOLTS/DIV — provides twelve steps of attenuation of each channel's input signal. Calibrated sensitivities are only valid when VARIABLE is fully clockwise.

SET GAIN

5 mV — a preset; adjusts X1 gain calibration.

1 mV — a preset; adjusts X5 gain calibration.
NOTE: VARIABLE should be fully clockwise.

VARIABLE — enables all deflection sensitivities between that selected by the VOLTS/DIV switch and the next below to be covered. When pulled magnifies the display 5 times in the vertical axis. The control must be fully clockwise for a calibrated display.

INVERT — the setting of this button determines whether the CH2 signal is displayed in the same polarity as the input signal or inverted. The inverted setting is used to display the difference between two signals of the same phase in the SUM mode.

TRIG SELECT — selects triggering from either channel or display.

POSITION — moves the respective trace in the vertical axis.

DC BAL — preset, adjusted to eliminate trace movement when the respective VARIABLE are pulled.

CHANNEL SELECT

CH1 — selects Channel 1.

CHOP — the channels are alternately switched on and off at a frequency of about 350 kHz; this mode is suitable for lower sweep speeds.

SUM — the display is the addition of the individual signals. If INVERT is pulled, the resultant display is the difference between two input signals.

ALT — each channel is alternately displayed for the duration of a sweep; the ALT mode is preferable at higher sweep speeds.

CH2 — selects Channel 2.

2.1.5 **CONNECTORS**

INPUTS

CH1/CH2 — BNC sockets connect the signal to be viewed to the respective vertical amplifier.

OUTPUTS

terminal connected to the chassis of the instrument.

INTERFACE — edge connector situated at the rear; connects with mother-board in the parent unit.

2.2 PRE-OPERATIONAL CHECKS

Note: Reference should be made to the "PU" and "S" manuals for control settings and operation.

2.2.1 **POWER SUPPLY.** See "PU" Manual.

2.2.2 **CONTROL SETTINGS**

1. CRT See "PU" Manual.
2. "S" Module See "S" Manual.
3. Set controls as follows:

TRIG SELECT	CH1
CHANNEL SELECT	CH1
POSITION	Central
VOLTS/DIV	5 mV
INVERT	depressed
VARIABLE	fully clockwise
DC-GND-AC	GND
INPUT CONNECTION	CH1

2.3 OPERATION. See "PU" Manual.

CHAPTER 3

CIRCUIT DESCRIPTION

3.1 VERTICAL AMPLIFIER

The V4 module consists of 2 amplifiers, which are switched in various ways to feed a single main amplifier in the parent unit.

3.1.1 The input attenuators, reference Figure 1, are simply capacity compensated L type sections which are switched singly or in cascade to obtain the correct attenuation. The sections on the back of the attenuator are the ÷1, ÷2 and ÷4; on the front are the ÷10, ÷100 and ÷1000. The input impedance of the attenuator is maintained at 1 MΩ and 29 pF on all positions. The attenuators are identical electrically.

The DC-GND-AC switches select either a through connection on DC, a capacitor coupled connection via a 0·1 μF 400 V capacitor on AC or a GND connection with the signal path input open circuited and the amplifier input grounded.

3.1.2 The circuits of channel 1 (CH1) and channel 2 (CH2) are very similar. CH1 is desicribed below with reference to Figure 2, except where reference is made to CH2. TR601B are a matched pair of FETS used as source followers which drive TR605A and TR605B a phase-splitting stage. These are a long-tailed pair with the 1 mV and 5 mV SET CAL potentiometers, R696 and R625 in the emitter circuit. DC BAL R601, is adjusted to eliminate trace movement, when gain is switched. The collectors are connected to a voltage feedback stage, TR609 and TR611 via the variable VOLTS/DIV circuitry. The input impedance of this stage is very low and its total input resistance, including the 91 Ω resistors R646 and R647, is approximately 100 Ω per side. When the variable VOLTS/DIV potentiometer is at maximum resistance, the attenuation of the signal is small. When at minimum, however, the resistance is approximately 100 Ω. The attenuation of the signal is now 3 i.e. 300 Ω - 100 Ω. This covers the gaps in the 1-2-5 sequence in the attenuators. The shift or position signal is inserted at the bases of TR609 and TR611, after the VARIABLE control. This ensures that the same amount of shift is obtained regardless of VARIABLE setting.

3.1.3 The emitter followers TR614 and TR615 provide a low output impedance for the trigger pick-off and a low capacity loading for the voltage feedback stage. The CH1 trigger signal is fed to the bases of TR756 and TR757, which are a long-tailed pair then from their collectors, via a diode matrix, to the parent unit trigger interface. The diode matrix allows the trigger signals to be switched from CH1, CH2 or the displayed signal merely by changing DC levels; +24 V switches the channel on and −24 V off. The display or ALT trigger pick-off circuitry is on the parent unit mother board.

TR618 and TR619 are series feedback stages with HF peaking between their emitters. The voltage swing at their bases is approximately 22 mV/div/side or 44 mV/div push-pull. Their collectors feed the parent unit interface via the channel select diode matrix.

3.1.4 When CH1 is selected, reference Figure 3, the voltage at eyelet 152/24 is taken to +11 V and at eyelet 152/23 to +15 V. This reverse biases D605, D606, D611 and D613 and switches on D612, D609, D607 and D608. The signal current now passes through D609 and D612. The interface voltage level is approximately +12·7 V and the interface current sensitivity is approximately 0·27 mA/div/side. This gives a voltage swing of 25 mV/div/side as the input impedance of the parent unit is 100 Ω/side approximately.

3.1.5 When CH2 is selected D612, D609, D607 and D608 are reverse biased and D605, D606, D611 and D613 are switched on. The signal current now flows in D611 and D613. Pin 152/24 is at +15 V and pin 152/23 +11 V.

On CHOP these levels are switched at approximately 350 kHz and on ALT at sweep repetition rate. The switching signals are obtained from TR751 and TR753 collectors on PC153, eyelets 153/14 and 153/17. The switching levels are +11 V and +15 V. TR751 controls CH2 and TR753 CH1. The collectors and bases are cross-coupled to ensure bistable operation. When CH1 is selected the emitter of TR751 is open-circuited, thus switching it off and TR753 on. The reverse happens when CH2 is selected.

3.1.6 When SUM is selected, both transistors are saturated and R771 is switched into circuit to reduce the current drain from the supply.

3.1.7 On ALT, the circuit operates as a bistable, triggered by negative pulses from the sweep circuit. D751 and D753 are the steering diodes, C750 and C754 the input capacitors. The cross-coupling resistors R756 and R761 are non-symmetrical to ensure that the circuit does not achieve a third stable state with both collectors resting at +13·5 V due to low common mode gain.

3.1.8 On CHOP, the circuit operates as an emitter-coupled multivibrator. R757, C751, C752 and R762 form the timing circuit and C753 provides a blanking pulse output at twice the chop frequency. TR752 is the blanking amplifier and shaper giving a current pulse via D752 to the parent unit interface.

3.1.9 CH2 has an invert facility, a 2-pole change-over switch, S601, which re-routes the signal current when the invert knob is pulled. On CH1, the R703 is used to eliminate trace movement, when operating the VARIABLE. On CH2 the R702 is used to equalize the currents through the two switch paths, so that no movement occurs on normal invert operation. R645 provides the balance control for the VARIABLE movement and R602 the balance control for gain switch movement. The CH2 trigger signal is fed to the bases of TR758 and TR759 then through the diode matrix to the parent unit interface.

CHAPTER 4

MAINTENANCE AND CALIBRATION

4.1.0 GENERAL

4.1.1 This manual should be read in conjunction with the manuals for the parent unit and module in use.

4.1.2 Before it is assumed a fault condition exists, control settings should be verified with reference to the pre-operational checks, para. 2.2. Where components are replaced, e.g., transistors, it is advised that the calibration checks detailed in para. 4.4.0 be carried out.

4.2.0 MECHANICAL

4.2.1 **ACCESS TO INTERIOR**

Withdraw module and remove covers.

4.2.2 **LOCATION OF PRESET CONTROLS**

Attenuator (PC137) and Vertical amplifier (PC152) are situated on the left. Trigger amplifier (PC153) on the right.

4.3.0 CALIBRATION

4.3.1 The following procedure enables a calibration check of the unit to be accomplished. It is advised, that isolated adjustments are not made, due to risk of interaction with settings made in earlier checks. A functional check may be carried out as detailed in para. 4.4 below, checking parameters are met, then proceeding to the next check. Adjustmetns, if made, should be minimal, except when setting-up procedures are referred to.

The following tools and facilities will be required:

TOOLS

Screwdrivers	Plain 4 mm. blade. Non-capacitive.
Leads	Extension, Module, 195-0112-00.
Adaptors	Screened c/w BNC Adaptors, BNC 3-way, Male/Female/Male. BNC/2 mm.

Normalizer or capacitance measuring facility 29 pF.
Probe for voltage measurement.

FACILITIES

Input Signals

Sinewave	Squarewave
25 mV 50 kHz	
	25 mV 1 kHz 1%
50 kHz	50 mV 1 kHz 1%
	100 mV 1 kHz 1%
	250 mV 1 kHz 1%
	500 mV 1 kHz 1%
	1 V 1 kHz 1%
	2·5 V 1 kHz 1%
15 MHz	5·0 V 1 kHz 1%
	25 V 1 kHz 1%
	50 V 1 kHz 1%
	25 mV 1 MHz <10 ns risetime

4.3.2 **INITIAL SETTING**

(a) Set both DC-GND-AC to GND.
(b) Turn both VARIABLEs fully clockwise.
(c) Push CH1 (Trig & Channel Select).
(d) Push INVERT.

Note: Reference should be made to "PU" and "S" manuals for the respective initial control settings.

4.4.0 CALIBRATION PROCEDURE

4.4.1 **CONTROLS. Front panel**

1.0 Check vertical controls.

1.1 Rotate CH1 POSITION
1.2 Observe trace moves vertically.
1.3 Push CH2 (Trig and Channel Select)
1.4 Rotate CH2 POSITION.
1.5 Observe trace moves vertically.
1.6 Push ALT (Trig Select) and CHOP.
1.7 CHECK trace=3·5±1 cycle.
1.8 Push ALT (Channel Select) and CH1 (Trig Select).
1.9 Set TIME/DIV to 50 ms.
1.10 Observe trace alternates.
1.11 Push SUM
1.12 Repeat Ops. 1.1, 1.2, 1.4 and 1.5.

4.4.2 **VERTICAL AMPLIFIER balance**

1.0 Check CH1 X5 balance.

1.1 Adjust POSITION for trace/horizontal centre alignment.
1.2 Pull VARIABLE.
1.3 Observe trace for movement.
1.4 Adjust DC BAL to centralize trace.
1.5 Push VARIABLE.
1.6 Observe trace for movement.
1.7 Repeat Ops. 1.1 through 1.6 till no movement occurs.

Note 1: Remove 'PU' cover, reference para. 4.2.1, and 'V' module L.H. cover.

Note 2: Should drift occur, screen module.

2.0 Check CH1 variable gail balance.

2.1 Push CH1 (Trig and Channel Select).
2.2 Turn VARIABLE anti-clockwise.
2.3 Observe trace for movement.
2.4 Set trace to graticule horizontal centre line.
2.5 Turn VARIABLE fully clockwise.
2.6 Adjust R703, PC152 to centralize trace.
2.7 Repeat Ops. 2.2 through 2.5 till no movement occurs.

3.0 Check CH2 X5 balance.

3.1 Repeat Ops. 1.1 through 1.7 using corresponding CH2 controls.

4.0 Check INVERT balance.

4.1 Push CH2 (Trig and Channel Select).
4.2 NOTE trace position.
4.3 Pull INVERT.
4.4 Observe trace for movement. Note new position.
4.5 Adjust R704, PC152 to centralize trace between Ops. 4.2 and 4.4.

4.6 Push INVERT.

4.7 Repeat Ops. 4.2 through 4.5 until no movement observed.

5.0 Check CH2 variable gain balance.

5.1 Remove 'PU' cover, reference para. 4.2.1, and 'V' module L.H. cover.

Note: Should trace drift occur, screen module.

5.2 Slide module into parent unit.

5.3 Repeat Ops. 2.1 through 2.7 using CH2 controls adjusting R645.

5.4 Remove 'V' module, replace module covers, slide module back.

4.4.3 **VERTICAL AMPLIFIER (Input Stage)**

1.0 Check CH1 Cal and Variable range.

1.1 Set TIME/DIV to 0·1 ms.

1.2 Connect 25 mV, 1 kHz squarewave to CH1.

1.3 Push VARIABLE CH1 (Trig and Channel Select).

1.4 Set DC-GND-AC to DC.

1.5 Set VOLTS/DIV to 5 mV.

1.6 Rotate SET GAIN.

1.7 CHECK amplitude from ranges <4·5 to >5·5 divisions.

1.8 Set amplitude to 5 divisions.

1.9 Rotate VARIABLE fully anti-clockwise.

1.10 CHECK amplitude <2·0 Divs.

1.11 Turn VARIABLE fully clockwise.

1.12 Pull VARIABLE.

1.13 Reduce input to 5 mV.

1.14 Repeat Ops. 1.6 through 1.10.

1.15 Push VARIABLE.

2.0 Check CH2 Cal and Variable range.

2.1 Repeat Ops. 1.2 through 1.15 using corresponding CH2 controls.

3.0 Check CH1 trigger.

3.1 Remove 'V' module, remove RH cover and install module.

3.2 Remove 'S' module and connect with extension lead to Parent Unit

3.3 Repeat Ops. 1.2, 1.4 and 1.5.

3.4 Push ALT (Trig).

3.5a Set 'S' module to DC.

b Adjust LEVEL to start trace on centre line.

3.6 Note point of trace start.

3.7 Push CH1 (Trig).

3.8 CHECK point alignment with Op. 3.6.

3.9 Adjust R797, PC152, to align.

4.0 Check CH2 trigger.

4.1 Connect 25 mV, 1 kHz sinewave to CH2.

4.2 Push CH1 (Trig).

4.3 CHECK point alignment with Op. 3.6.

4.4 Adjust R798, PC153, to align.

4.4.12 **ATTENUATOR**

Note: Remove 'V' module, remove 'S' module extension lead and install 'S' module, fit RH cover, connect module to Parent Unit with extension lead and slide module in; draw 'V' module out sufficiently to gain access to presets.

1.0 Check CH1 attenuator.

1.1 Connect 25 mV, 1 kHz squarewave, via *Input Normalizer to CH1.

1.2 Push CH1 (Trig and Channel Select).

1.3 Set DC-GND-AC to DC.

1.4 Set VOLTS/DIV to Col. 1.

1.5 Set Signal Generator to Col. 2

1.6 CHECK 5 div trace for over or undershoot.

Col. 1 VOLTS/DIV	Col. 2 1 kHz Squarewave	Col. 3 Adjust
5 mV	50 mV	C916, PC137
Remove Input Normalizer		
10 mV	50 mV	C917, PC137
20 mV	100 mV	C918, PC137
50 mV	250 mV	C907, PC137
0·1 V	500 mV	C915, PC137
0·2 V	1 V	C914, PC137
0·5 V	2·5 V	C906, PC137
5 V	25 V	C905, PC137
Fit Input Normalizer		
50 mV	500 mV	C904, PC137
0·5 V	5·0 V	C903, PC137
5·0 V	50 V	C902, PC137

2.0 Check CH2 attenuator.

2.1 Repeat Ops. 1.1 through 1.6 using corresponding CH2 controls.

Note: Remove 'V' module LH cover, use temporary screen should oscillation occur.

3.0 Check CH2 Pulse response.

Note: Remove extension Lead, install module.

3.1 Connect 25 mV, 1 MHz <10 ns risetime squarewave to CH2.

3.2 Set VOLTS/DIV to give 5 div trace.

3.3 Set TIME/DIV to 0·1 μs.

3.4 Push VARIABLE and CH1 (Trig and Channel Select).

3.5 CHECK trace overshoot <0·1 div.

3.6 Adjust C616 and R689, PC152, for optimum response.

4.0 Check CH1 risetime.

4.1 Repeat Ops. 3.1 through 3.3.

4.2 Set 'PU' to maximum expansion.

4.3 CHECK 10%-90% risetime <0·7±0·1 divisions, reference Plate 4.1.

4.4 Adjust C614, PC152, for perpendicular leading edge.

5.0 Check CH2 Pulse response.

5.1 Set 'PU' to minimum expansion.

5.2 Repeat Ops. 3.1 through 3.6 using corresponding CH1 controls.

5.3 Adjust C617, R689, PC152, for optimum response.

6.0 Check CH2 risetime.

6.1 Repeat Ops. 4.1 and 4.3.

6.2 Adjust C614, PC152.

7.0 Check CH1 X1 Bandwidth.

7.1 Connect 50 kHz sinewave to CH1.

7.2 Set TIME/DIV to 1 ms.

7.3 Set VOLTS/DIV to give 6 div display.

7.4 Set Signal Generator to 50 MHz.

7.5 CHECK amplitude >4·2 divisions.

8.0 Check CH1 X5 Bandwidth.

8.1 Pull VARIABLE.

8.2 Repeat Ops. 7.1 through 7.5.

9.0 Check CH2 X1 Bandwidth.

9.1 Repeat Ops. 7.1 through 7.5 using corresponding CH2 controls.

10.0 Check CH2 X5 Bandwidth.

10.1 Repeat Ops. 8.1 and 9.1.

11.0 Repeat para. 4.4.2, Ops. 1.0 and 3.0

* or use Capacitance meter set to 29 pF.

Refers to para 4.4.12 of 4.0

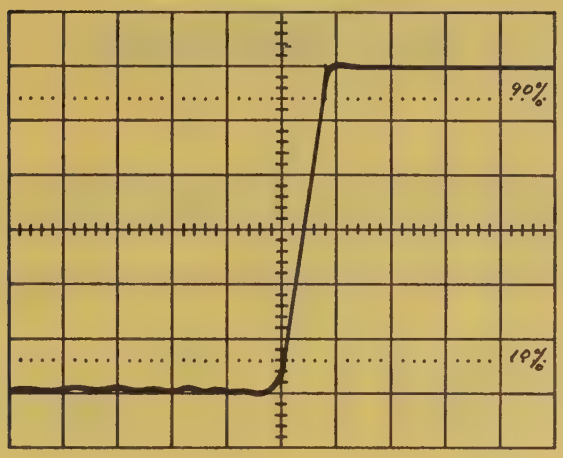
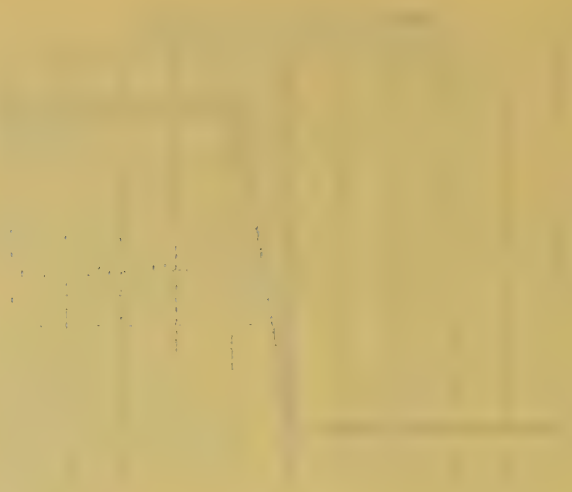


PLATE 4.1



CHAPTER 5
COMPONENT LIST

Values of resistors are stated in ohms or multiples of ohms; ratings at 70°C are in watts or sub-multiples of watts. Values of capacitors are stated in sub-multiples of farads; ratings at 70°C are in volts or kilovolts.

Whenever possible, exact replacements for components should be used, although locally available alternative may be satisfactory for standard components.

Any order for replacement parts should include:

1. Instrument type
2. Instrument serial number
3. Component circuit reference
4. Component part number
5. Component Value

CIRCUIT REFERENCE BLOCKS

The table below gives the blocks of circuit references, so that the reader can relate the items listed in this chapter and their location in the circuitry and printed circuit boards in Chapter 6.

Circuit Reference		Circuit	Fig.	P.C. Board No.
From	To			
601	700	Dual Trace Amplifier	2	130
751	800		3	131
901	950	Volts/Div Switch	1	137

ABBREVIATIONS

BM	Button mica	CMP	Cermet preset	PS	Polystyrene
C	Carbon	E	Electrolytic	Se	Selenium
CP	Carbon preset	Ge	Germanium	Si	Silicon
CV	Carbon variable	MF	Metal film	SM	Silver mica
CER	Ceramic	MO	Metal oxide	WW	Wire-wound
CT	Ceramic trimmer	PE	Polyester	WWP	Wire-wound preset
CM	Cermet thick film	PP	Polypropylene	WWV	Wire-wound variable

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All requests for repairs or replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service.

ELECTRICAL

Cir Ref	Part Number	Description Value F	Type	Tol %	Rating V
C601	285-0915-00	100 n	PE	20	100
C602	285-0915-00	100 n	PE	20	100
C603	281-0710-00	10 n	CER		250
C604	285-1014-00	1 μ	PE	20	63
C605	285-1053-00	3·3 n	PS	5	160
C606	285-1053-00	3·3 n	PS	5	160
C607	285-1053-00	3·3 n	PS	5	160
C608	285-1053-00	3·3 n	PS	5	160
C609	281-0710-00	10 n	CER		250
C611	281-0710-00	10 n	CER		250
C612	281-0710-00	10 n	CER		250
C613	281-0710-00	10 n	CER		250
C614	281-0155-00	2-22 p	PP		500
C615	281-0155-00	2-22 p	PP		500
C616	281-0155-00	2-22 p	PP		500
C617	281-0155-00	2-22 p	PP		500
C618	281-0710-00	10 n	CER		250
C619	285-1014-00	1 μ	PE	20	63
C621	285-1014-00	1 μ	PE	20	63
C622	285-1014-00	1 μ	PE	20	63
C623	285-1014-00	1 μ	PE	20	63
C750	285-0854-00	100 p	PS	2 p	350
C751	285-0800-00	10 n	PE	20	250
C752	285-0800-00	10 n	PE	20	250
C753	285-0810-00	820 p	PS	5	125
C754	285-0854-00	100 p	PS	2 p	350
C755	285-0800-00	10 n	PE	20	250
C756	281-0710-00	10 n	CER		250
C757	290-0623-00	4·7 μ	E		25
C758	285-0759-00	2·2 n	PS	5	125
C762	281-0731-00	5·6 p	CER	0·5 p	750
C763	281-0731-00	5·6 p	CER	0·5 p	750
*C901	285-0772-00	100 n	PE	10	400
*C902	281-0155-00	2-22 p	PP		500
*C903	281-0155-00	2-22 p	PP		500
*C904	281-0155-00	2-22 p	PP		500
*C905	281-0156-00	1·4-6·4 p	PP		500
*C906	281-0156-00	1·4-6·4 p	PP		500
*C907	281-0154-00	2-12 p	PP		500
*C908	285-0872-00	180 p	PS	2	350
*C909	283-0607-00	2 n	BM	10	500
*C911	283-0719-00	470 p	BM	10	500
*C912	285-0844-00	39 p	PS	2 p	350
*C913	285-0869-00	47 p	PS	2 p	350
*C914	281-0154-00	2-12 p	PP		500
*C915	281-0156-00	1·4-6·4 p	PP		500
*C916	281-0154-00	2-12 p	PP		500
*C917	281-0155-00	2-22 p	PP		500
*C918	281-0154-00	2-12 p	PP		500
*C919	283-0662-00	7·5 p	SM	0·5 p	350
*C921	285-1017-00	10 n	PE	20	500

*Two per unit

Cir Ref	Part Number	Value	Description	Type	Tol %	Rating
D601	152-0565-00		EXP 5072A	Si		
D602	152-0565-00		EXP 5072A	Si		
D603	152-0543-00	5·1 V	Zener	Si	5	330 mW
D604	152-0416-00	8·2 V	Zener	Si	5	330 mW
D605	152-0554-00		BAY 74	Si		50 V
D606	152-0554-00		BAY 74	Si		50 V
D607	152-0554-00		BAY 74	Si		50 V
D608	152-0554-00		BAY 74	Si		50 V
D609	152-0062-01		1N914/1N4148	Si		75 V
D611	152-0062-01		1N914/1N4148	Si		75 V
D612	152-0062-01		1N914/1N4148	Si		75 V
D613	152-0062-01		1N914/1N4148	Si		75 V

Cir Ref	Part Number	Value	Description	Type	Tol %	Rating
D751	152-0062-01		1N914/1N4148	Si		75 V
D752	152-0062-01		1N914/1N4148	Si		75 V
D753	152-0062-01		1N914/1N4148	Si		75 V
D754	152-0062-01		1N914/1N4148	Si		75 V
D755	152-0062-01		1N914/1N4148	Si		75 V
D756	152-0062-01		1N914/1N4148	Si		75 V
D757	152-0062-01		1N914/1N4148	Si		75 V
D758	152-0062-01		1N914/1N4148	Si		75 V
D759	152-0062-01		1N914/1N4148	Si		75 V
D761	152-0062-01		1N914/1N4148	Si		75 V
D762	152-0062-01		1N914/1N4148	Si		75 V

Cir Ref	Part Number	Description Value Ohms	Type	Tol %	Rating W
*R601	311-1352-00	47 k	CV	20	250 m
†R602	311-1352-00	47 k	CV	20	250 m
R603	317-0224-01	220 k	C	5	125 m
R604	317-0224-01	220 k	C	5	125 m
R605	317-0122-01	1·2 k	C	5	125 m
R606	317-0122-01	1·2 k	C	5	125 m
R607	317-0101-01	100	C	5	125 m
R608	317-0101-01	100	C	5	125 m
R609	317-0101-01	100	C	5	125 m
R611	317-0101-01	100	C	5	125 m
R612	317-0472-01	4·7 k	C	5	125 m
R613	317-0472-01	4·7 k	C	5	125 m
R614	317-0103-01	10 k	C	5	125 m
R615	317-0472-01	4·7 k	C	5	125 m
R616	317-0472-01	4·7 k	C	5	125 m
R617	317-0221-01	220	C	5	125 m
R618	317-0221-01	220	C	5	125 m
R619	317-0221-01	220	C	5	125 m
R621	317-0390-01	39	C	5	125 m
R622	317-0390-01	39	C	5	125 m
R623	317-0390-01	39	C	5	125 m
R624	317-0390-01	39	C	5	125 m
R625	311-1350-00	100	CP	20	250 m
R626	311-1350-00	100	CP	20	250 m
R627	317-0512-01	5·1 k	C	5	125 m
R628	317-0512-01	5·1 k	C	5	125 m
R629	317-0472-01	4·7 k	C	5	125 m
R631	317-0472-01	4·7 k	C	5	125 m
R632	317-0821-01	820	C	5	125 m
R633	317-0821-01	820	C	5	125 m
R634	317-0821-01	820	C	5	125 m
R635	317-0821-01	820	C	5	125 m
R636	317-0510-01	51	C	5	125 m
R637	317-0510-01	51	C	5	125 m
R638	317-0510-01	51	C	5	125 m
R639	317-0510-01	51	C	5	125 m
‡R641	311-1471-00	2·2 k	CV	20	250 m
§R642	311-1471-00	2·2 k	CV	20	250 m
R643	317-0473-01	47 k	C	5	125 m
R644	317-0473-01	47 k	C	5	125 m
R645	311-0765-00	100 k	CP	20	250 m
R646	321-0968-48	91	MF	1	125 m

Cir Ref	Part Number	Description Value Ohms	Type	Tol %	Rating W
R647	321-0968-48	91	MF	1	125 m
R648	321-0968-48	91	MF	1	125 m
R649	321-0968-48	91	MF	1	125 m
R651	317-0472-01	4·7 k	C	5	125 m
R652	317-0472-01	4·7 k	C	5	125 m
R653	317-0472-01	4·7 k	C	5	125 m
R654	317-0472-01	4·7 k	C	5	125 m
*R655	311-1352-00	1·5 k	CV	20	250 m
†R656	311-1352-00	1·5 k	CV	20	250 m
R657	321-0862-48	620	MF	1	125 m
R658	321-0862-48	620	MF	1	125 m
R659	321-0862-48	620	MF	1	125 m
R661	321-0862-48	620	MF	1	125 m
R662	315-0621-02	620	C	5	250 m
R663	315-0621-02	620	C	5	250 m
R664	317-0361-01	360	C	5	125 m
R665	317-0361-01	360	C	5	125 m
R666	317-0471-01	470	C	5	125 m
R667	317-0471-01	470	C	5	125 m
R668	317-0471-01	470	C	5	125 m
R669	317-0471-01	470	C	5	125 m
R671	317-0272-01	2·7 k	C	5	125 m
R672	317-0272-01	2·7 k	C	5	125 m
R673	317-0272-01	2·7 k	C	5	125 m
R674	317-0272-01	2·7 k	C	5	125 m
R675	317-0100-01	10	C	5	125 m
R676	317-0100-01	10	C	5	125 m
R677	317-0220-01	22	C	5	125 m
R678	317-0220-01	22	C	5	125 m
R679	317-0220-01	22	C	5	125 m
R681	317-0220-01	22	C	5	125 m
R682	317-0162-01	1·6 k	C	5	125 m
R683	317-0162-01	1·6 k	C	5	125 m
R684	317-0162-01	1·6 k	C	5	125 m
R685	317-0162-01	1·6 k	C	5	125 m
R686	317-0151-01	150	C	5	125 m
R687	317-0151-01	150	C	5	125 m
R688	311-0717-00	220	CP	20	250 m
R689	311-0717-00	220	CP	20	250 m
R691	307-0394-00	3·9	C	5	125 m

* † Dual pot
‡ with S602
§ with S603

Cir Ref	Part Number	Description Value Ohms	Type	Tol %	Rating W
R694	317-0220-01	22	C	5	125 m
R695	317-0220-01	22	C	5	125 m
R696	311-1481-00	47	CP	20	250 m
R697	311-1481-00	47	CP	20	250 m
R698	317-0047-01	4·7	C	5	125 m
R699	317-0047-01	4·7	C	5	125 m
R701	317-0473-01	47 k	C	5	125 m
R702	317-0473-01	47 k	C	5	125 m
R703	311-0765-00	100 k	CP	20	250 m
R704	311-0995-00	680	CP	20	250 m
R705	317-0151-01	150	C	5	125 m
R706	317-0151-01	150	C	5	125 m
R751	317-0103-01	10 k	C	5	125 m
R752	317-0393-01	39 k	C	5	125 m
R753	317-0470-01	47	C	5	125 m
R754	317-0473-01	47 k	C	5	125 m
R755	315-0621-02	620	C	5	250 m
R756	317-0472-02	4·7 k	C	5	125 m
R757	317-0821-01	820	C	5	125 m
R758	315-0471-01	470	C	5	250 m
R759	317-0470-01	47	C	5	125 m
R761	317-0392-01	3·9 k	C	5	125 m
R762	317-0821-01	820	C	5	125 m
R763	317-0470-01	47	C	5	125 m
R764	317-0103-01	10 k	C	5	125 m
R765	317-0103-01	10 k	C	5	125 m
R766	317-0123-01	12 k	C	5	125 m
R767	317-0562-01	5·6 k	C	5	125 m
R768	315-0621-02	620	C	5	250 m
R769	307-0394-00	3·9	C	5	125 m
R771	315-0122-02	1·2 k	C	5	250 m
R772	317-0473-01	47 k	C	5	125 m
R773	317-0103-01	10 k	C	5	125 m
R774	317-0823-01	82 k	C	5	125 m

Cir Ref	Part Number	Description Value Ohms	Type	Tol %	Rating W
R786	317-0151-01	150	C	5	125 m
R787	317-0151-01	150	C	5	125 m
R788	317-0151-01	150	C	5	125 m
R789	317-0151-01	150	C	5	125 m
R791	317-0121-01	120	C	5	125 m
R792	317-0121-01	120	C	5	125 m
R793	317-0332-01	3·3 k	C	5	125 m
R794	317-0332-01	3·3 k	C	5	125 m
R795	317-0332-01	3·3 k	C	5	125 m
R796	317-0332-01	3·3 k	C	5	125 m
R797	311-0851-00	1 k	CP	20	250 m
R798	311-0851-00	1 k	CP	20	250 m
R799	317-0181-01	180	C	5	125 m
*R901	317-0100-01	10	C	5	125 m
*R902	321-0481-42	1 M	MF	0·5	125 m
*R903	325-0124-00	990 k	MF	0·5	125 m
*R904	325-0125-00	900 k	MF	0·5	125 m
*R905	317-0470-01	47	C	5	125 m
*R906	317-0101-01	100	C	5	125 m
*R907	317-0331-01	330	C	5	125 m
*R908	307-0382-00	7·5	C	5	125 m
*R909	321-0193-42	1 k	MF	0·5	125 m
*R911	321-1289-42	10·1 k	MF	0·5	125 m
*R912	321-1389-42	111 k	MF	0·5	125 m
*R913	317-0470-01	47	C	5	125 m
*R914	321-0970-42	500 k	MF	0·5	125 m
*R915	325-0126-00	750 k	MF	0·5	125 m
*R916	317-0470-01	47	C	5	125 m
*R917	321-0481-42	1 M	MF	0·5	125 m
*R918	316-0224-01	220 k	C	10	250 m
*R919	321-0481-48	1 M	MF	1	125 m
*R921	321-0628-42	333 k	MF	0·5	125 m

*Two per unit

Cir Ref	Part Number	Description
S601	260-1429-00	Slide (2 — position)
S602	311-1471-00	Push-Pull (R641)
S603	311-1471-00	Push-Pull (R642)
S751	260-1406-00	Push (5 — button)
S752	260-1407-00	Push (3 — button)

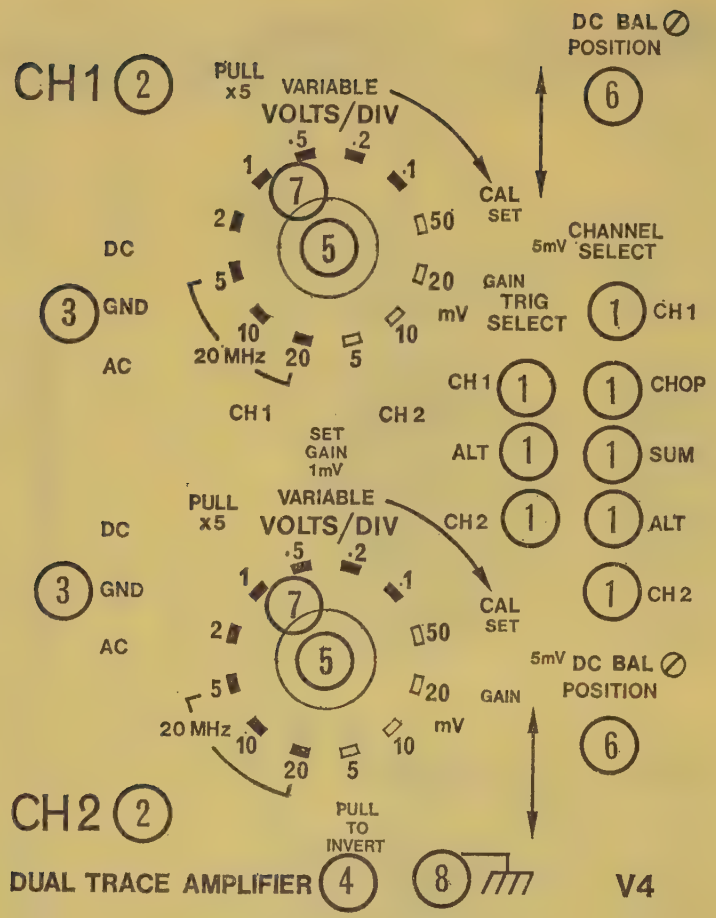
Cir Ref	Part Number	Description
*S901	260-1412-00	Lever (3 — position)
*S902	260-1409-00	Rotary (12 — position)
TH601	307-0403-00	Thermistor 4·7 Ω at 25° C
TH602	307-0403-00	Thermistor 4·7 Ω at 25° C

*Two per unit

Cir Ref	Part Number	Description		
TR601A B	151-1036-00	Dual FET	Si	N — channel
TR603A B	151-1036-00	Dual FET	Si	N — channel
TR605A B	151-0422-00	Dual, HD2369B Motorola	Si	NPN
TR607A B	151-0422-00	Dual, HD2369B Motorola	Si	NPN
TR609	151-0127-02	BSX20/2N2369	Si	NPN
TR611	151-0127-02	BSX20/2N2369	Si	NPN
TR612	151-0127-02	BSX20/2N2369	Si	NPN
TR613	151-0127-02	BSX20/2N2369	Si	NPN
TR614	151-0421-00	ZTX320/MPS918	Si	NPN
TR615	151-0421-00	ZTX320/MPS918	Si	NPN
TR616	151-0421-00	ZTX320/MPS918	Si	NPN
TR617	151-0421-00	ZTX320/MPS918	Si	NPN
TR618	151-0127-02	BSX20/2N2369	Si	NPN
TR619	151-0127-02	BSX20/2N2369	Si	NPN
TR621	151-0127-02	BSX20/2N2369	Si	NPN
TR622	151-0127-02	BSX20/2N2369	Si	NPN
TR751	151-0127-02	BSX20/2N2369	Si	NPN
TR752	151-0326-00	BC107	Si	NPN
TR755	151-0320-01	MPS6518 Motorola	Si	PNP
TR756	151-0320-01	MPS6518 Motorola	Si	PNP
TR757	151-0320-01	MPS6518 Motorola	Si	PNP
TR758	151-0320-01	MPS6518 Motorola	Si	PNP
TR759	151-0320-01	MPS6518 Motorola	Si	PNP

ASSEMBLIES

Assembly	Part Number	Includes Circuit References
Amplifier PC152	670-2557-00	C601 to C609, C611 to C618, D601 to D609, D611 to D613, R603 to R609, R611 to R619, R621 to R624, R627 to R629, R631 to R635, R643 to R649, R651 to R654, R657 to R659, R661 to R669, R671 to R679, R681 to R689, R691, R694 to R699, R701 to R706, S601, TR601 to TR609, TR611 to TR619, TR621, TR622.
Attenuator CH1	011-0114-01	C901, C913, C921, PC137, R901, R905 to R907, R913 to R919, R921, S902
Attenuator CH2	011-0114-00	C901, C913, C921, PC137, R901, R905 to R907, R913 to R919, S902.
PC137	670-2191-00	C902 to C909, C911, C912, C914 to C919, R902 to R908, R909, R911, R912
Trigger PC153	670-2658-00	C750 to C758, C762, C763, D751 to D759, D761, D762, R751, R752, R754 to R758, R761 to R765, R767 to R769, R771 to R774, R779, R786 to R789, R791 to R798, S751, S752, TR751 to TR753, TR756 to TR759.



FRONT PANEL

ELECTRICAL

Part Number	Description	Location
136-0344-00	Base Transistor, 4 pin	PCB
136-0343-00	Base Transistor, T018	PCB
366-1403-00	Button, Push	1
131-0649-00	Connector, Male BNC	Accessory
131-0650-01	Connector, Bulkhead Socket	2
131-0651-01	Connector, Panel Jack	3
210-0735-00	Eyelet, L.613	PCB
210-0739-00	Eyelet, L.737	PCB
342-0177-00	Insulator, Feed Thru.	PC130
003-0674-00	Key, Allen 1·5 A/F	4-7
366-1404-00	Knob, Push-Pull	4
366-1266-01	Knob, Red/Red	5
366-1254-00	Knob, Grey	6
366-1387-00	Knob, Grey	7
220-0647-00	Nut	8
220-0527-00	Nut, Chrome	4-7
004-1143-00	Packaging	Accessory
129-0374-00	Post, Terminal	8
213-0248-00	Screw, Socket, 3 x 3 mm lg.	4-7
162-0058-00	Sleeving, PTFE ·035"	
361-0223-00	Spacer, 6 BA	PCB
385-0206-00	Spacer, 6 BA/8 BA x ·05"	1
105-0347-00	Stop	Rear of Mod.
210-0275-00	Tag, Solder, ⅜"	

CHAPTER 6

CIRCUIT DIAGRAMS

To minimize the risk of misinterpretation of component values on circuit diagrams, the decimal point has been replaced by the multiplier or sub-multiplier of the basic unit. For instance, 2·2 megohms is shown as 2M2 and 1·8 picofarads is shown as 1p8.

To aid the reader further, in addition to the block Circuit Reference Table in Chapter 5.1, to locate a component in the circuit diagrams, a table is provided at the top of each circuit diagram, in which the circuit reference will appear, where practicable, directly above the component being sought.

PRINTED CIRCUIT

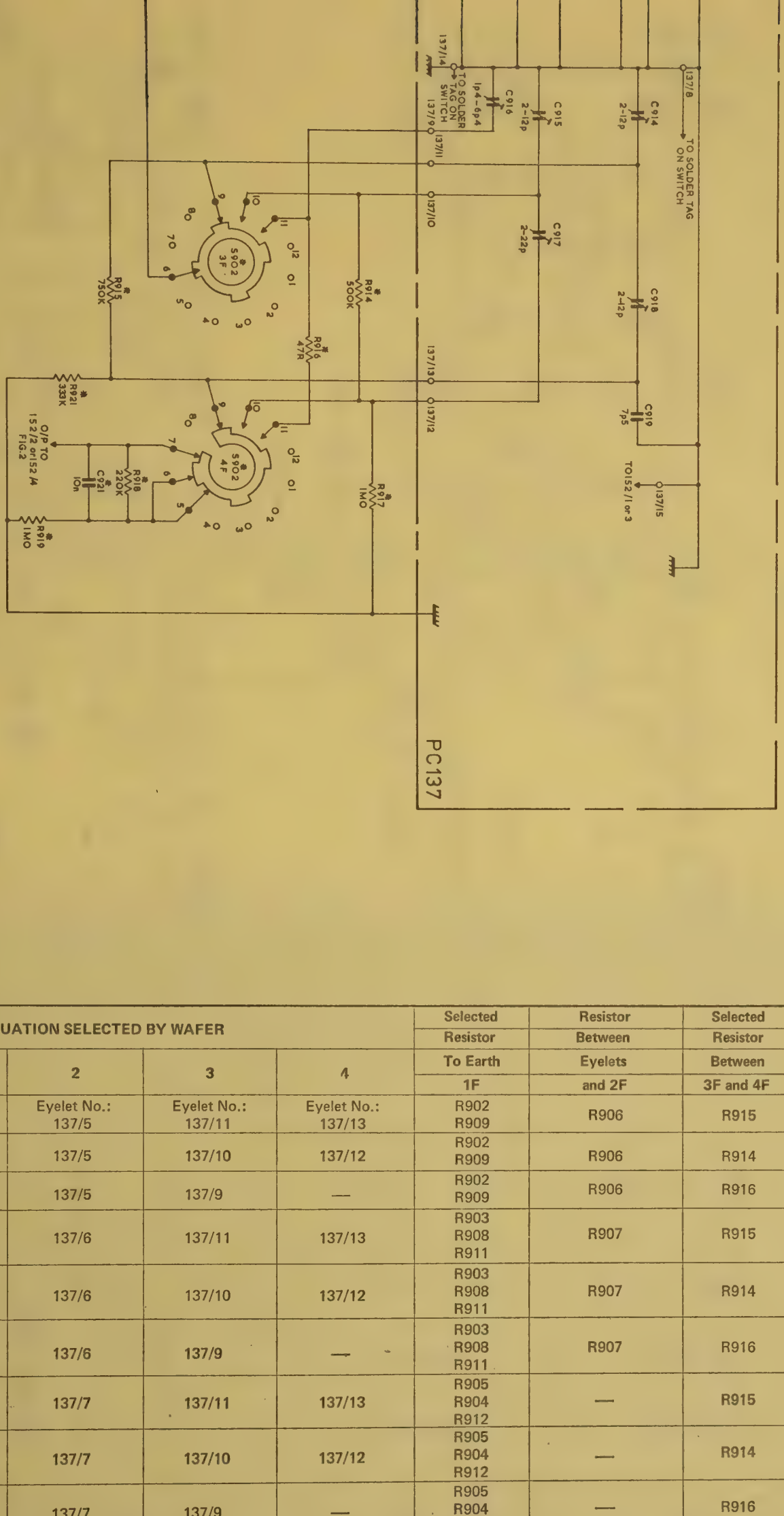
Blue shows the rear track as seen through the board. Yellow the component side track.

Location of components are listed on the page preceding the PCBs.

WAVEFORMS

Waveforms, illustrated in Plate 6/1, may be monitored at point with the corresponding number.

| | | |



DUAL TRACE AMPLIFIER TYPE V4
VOLTS/DIV SWITCH
FIG.1

ATTENUATION SELECTED BY WAFER					Selected Resistor To Earth 1F	Resistor Between Eyelets and 2F	Selected Resistor Between 3F and 4F	Selected Resistor Between 4F and Earth
Switch Position	1	2	3	4				
20 V	Eyelet No.: 137/2	Eyelet No.: 137/5	Eyelet No.: 137/11	Eyelet No.: 137/13	R902 R909	R906	R915	R921 R919
10 V	137/2	137/5	137/10	137/12	R902 R909	R906	R914	R917 R919
5 V	137/2	137/5	137/9	—	R902 R909	R906	R916	R919
2 V	137/3	137/6	137/11	137/13	R903 R908 R911	R907	R915	R921 R919
1 V	137/3	137/6	137/10	137/12	R903 R908 R911	R907	R914	R917 R919
0·5 V	137/3	137/6	137/9	—	R903 R908 R911	R907	R916	R919
0·2 V	137/4	137/7	137/11	137/13	R905 R904 R912	—	R915	R921 R919
0·1 V	137/4	137/7	137/10	137/12	R905 R904 R912	—	R914	R917 R919
50 mV	137/4	137/7	137/9	—	R905 R904 R912	—	R916	R919
20 mV	—	—	137/11	137/13	—	Resistor Between 1F & 2F R913	R915	R921 R919
10 mV	—	—	137/10	137/12	—	R913	R914	R917 R919
5 mV	—	—	137/9	—	—	R913	R916	R919

TABLE — VOLTS/DIV SWITCH CONNEXIONS

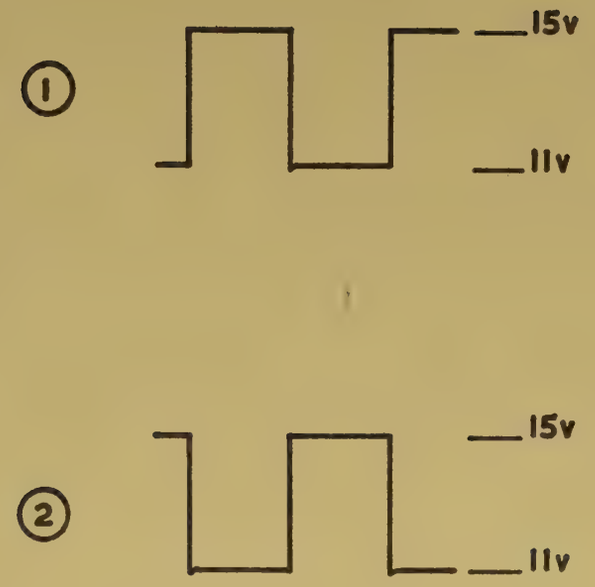


PLATE 6/1

| | | |

| | | |

LOCATION OF COMPONENTS ON PRINTED CIRCUITS

Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location	Cir Ref	Grid Location
C601	4– C6			D603	4– B5	R607		R647	4– C4	R687	4– B2	R765	4– F1	R901		TR611	4– C3
C602	4– B5			D604	4– C4	R608	4– C5	R648	4– B4	R688	4– C2	R766	4– F2	R902	4– E5	TR612	4– B3
C603	4– B6			D605	4– C2	R609		R649	4– B4	R689	4– B2	R767	4– F1	R903	4– E5	TR613	4– B3
C604	4– C5			D606	4– C2							R768	4– F3	R904	4– E6	TR614	4– C3
C605	4– C4			D607	4– B2	R611	4– B5	R651	4– C4	R691	4– D3	R769	4– F3	R905		TR615	4– C3
C606	4– C5			D608	4– B2	R612	4– C5	R652	4– C4					R906		TR616	4– B3
C607	4– A4			D609	4– C2	R613	4– C5	R653	4– A4			R771	4– F3	R907		TR617	4– B3
C608	4– B5	C901				R614	4– B5	R654	4– B4	R694	4–	R772	4– E3	R908		TR618	4– C2
C609	4– C3	C902	4– E5	D611	4– B2	R615	4– B5			R695	4–	R773	4– E3	R909	4– F5	TR619	4– C2
		C903	4– E5	D612	4– B2	R616	4– B5			R696	4–	R774	4– E3				
C611	4– B3	C904	4– E5	D613	4– B2	R617	4– C5	R657	4– C3	R697	4–			R911	4– F5	TR621	4– B2
C612	4– C3	C905	4– E5			R618	4– B5	R658	4– C3	R698	4– C4			R912	4– F6	TR622	4– B2
C613	4– B3	C906	4– E5			R619	4– C5	R659	4– A3	R699	4– B4			R913			
C614	4– C2	C907	4– E5											R914			
C615	4– B2	C908				R621	4– C4	R661	4– B3	R701	4– C4			R915			
C616	4– C2	C909	4– F5	D751	4– E2	R622	4– C5	R662	4– C3	R702	4– C4			R916			
C617	4– B2			D752	4– F2	R623	4– A5	R663	4– A3	R703	4– B4			R917			
C618	4– D3	C911	4– F5	D753	4– E3	R624	4– B4	R664	4– C3	R704	4– B5			R918			
C619	4– C5	C912	4– F5	D754	4– G2	R625		R665	4– B3	R705	4– D5	R786	4– G2	R919		TR751	4– E2
		C913		D755	4– G2	R626		R666	4– C3	R706	4– B5	R787	4– G1			TR752	4– F2
C621	4– A5	C914	4– F5	D756	4– G3	R627	4–	R667	4– C3			R788	4– G4	R921		TR753	4– E3
C622	4– D5	C915	4– F5	D757	4– G3	R628	4– C4	R668	4– B3			R789	4– G3				
C623	4– B5	C916	4– F5	D758	4– H2	R629	4– B4	R669	4– B3								
		C917	4– G5	D759	4– H3							R791	4– G2			TR756	4– G2
		C918	4– G5			R631	4– B4	R671	4– C3			R792	4– G3			TR757	4– G1
		C919	4– G5	D761	4– G3	R632	4– C4	R672	4– D3			R793	4– G2	TH601	4– C5	TR758	4– G4
C750	4– E3			D762	4– G3	R633	4– C5	R673	4– A3	R751	4– E2	R794	4– G2	TH602	4– B5	TR759	4– G3
C751	4– E2	C921				R634	4– A4	R674	4– B3	R752	4– E2	R795	4– G3				
C752	4– E2					R635	4– B5	R675	4– C3	R753	4– F2	R796	4– G3				
C753	4– E2					R636		R676	4– B3	R754	4– E3	R797	4– G2				
C754	4– E3					R637		R677	4– C3	R755	4– F2	R798	4– F3	TR601	4– C5		
C755	4– D1					R638		R678	4– C3	R756	4– F3	R799					
C756	4– F2					R639		R679	4– A3	R757	4– E2			TR603	4– B5		
C757	4– F3									R758	4– E1						
C758	4– E1			R601		R641		R681	4– B2	R759	4– F4			TR605	4– C5		
				R602		R642		R682	4– C2								
				R603	4– C5	R643	4– B4	R683	4– C2	R761	4– F3			TR607	4– B5		
				R604	4– A5	R644	4– B4	R684	4– B3	R762	4– E2						
C762	4– G2	D601	4– C5	R605	4– C6	R645	4– B4	R685	4– B2	R763	4– F3			TR609	4– C3		
C763	4– G3	D602	4– B6	R606	4– B5	R646	4– C4	R686	4– C2	R764	4– E2						

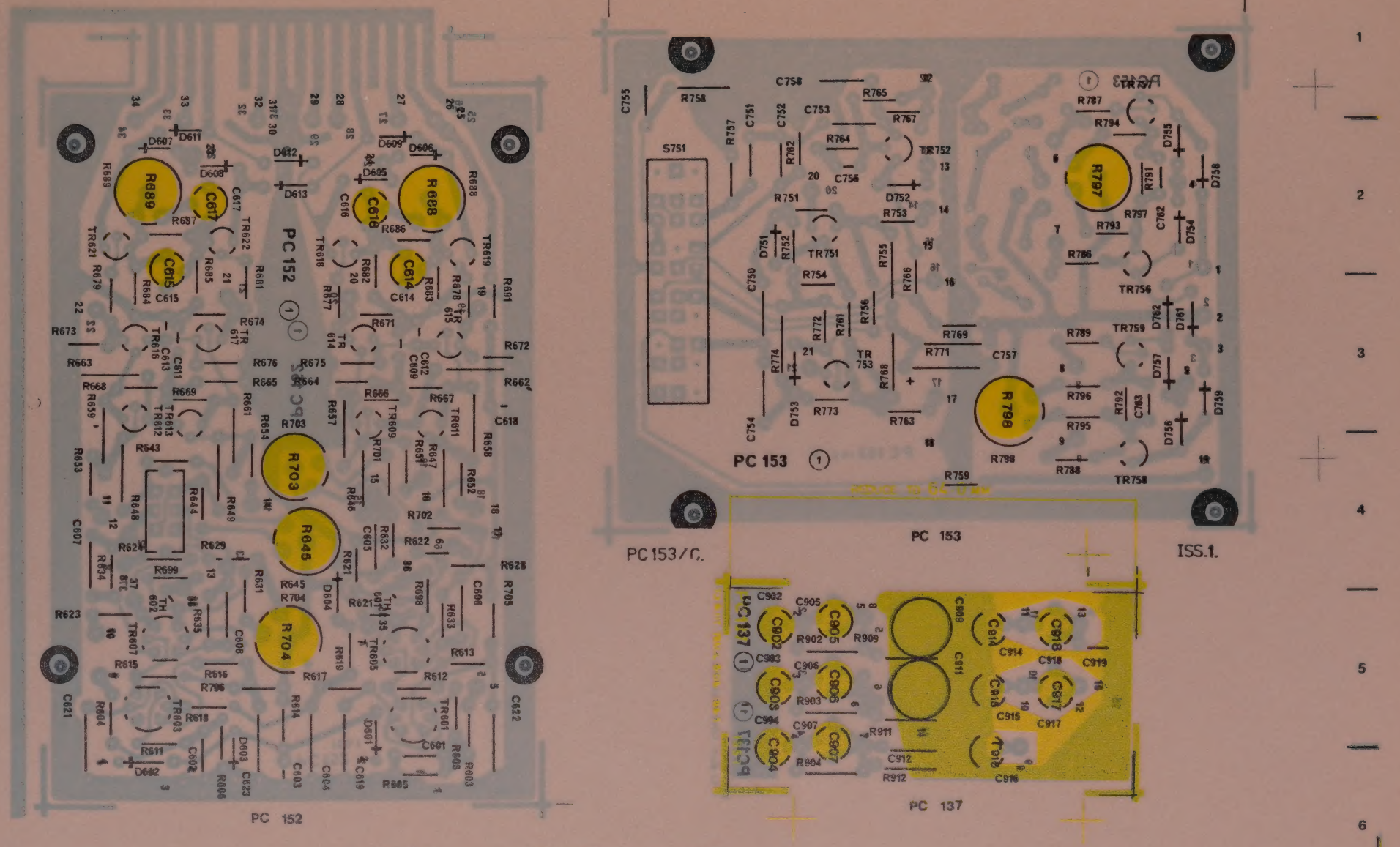


FIGURE 4 COMPONENT REFERENCE

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